

DESCRIPTION

5 MOUNTING METHOD AND REMOVAL METHOD FOR HEAT INSULATION STRUCTURE

Technical Field

[0001]

10 The present invention relates to a method of attaching a heat insulation structure comprising a plurality of heat insulating members juxtaposed along a circumferential direction of a cylindrical or hollow spherical heat insulation object to be cooled by a cold fluid for covering an outer circumference of the heat insulation object for its heat insulation.

15 The invention relates also to a method of detaching such heat insulation structure.

Background Art

[0002]

20 Such heat insulation structure is provided for, as a heat insulation object, a reservoir tank reserving an amount of a cold fluid such as LNG, etc. or a cylindrical tubing or piping (cylindrical tube) through which the cold fluid such as LNG, etc. flows, the structure being configured such that the heat insulation object is heat-insulated by a

25 plurality of heat insulating members juxtaposed in such a manner as to cover the outer circumference of the heat insulation object, namely, providing heat insulation of the outer circumferential portion of the heat insulation object which is cooled by the presence of the cold fluid therein.

[0003]

30 According to s a conventional example of such heat insulation structure, an outer circumference of a cylindrical tube as a heat insulation object is covered by a pair of semi-cylindrical heat insulating members and urethane foam agent is charged to the joining portion between the pair of semi-cylindrical heat insulating members, the semi-cylindrical

35 heat insulating members being subsequently joined to each other with foaming and subsequent solidifying of the charged urethane foam agent

(see Patent Document 1 for instance).

Prior Art Document

[0004]

5 Patent Document 1: Japanese Unexamined Patent Application
Publication No 2002-295729

Disclosure of the Invention

Problem to be Solved by Invention

10 **[0005]**

 With the heat insulation structure of Patent Document 1, when
the semi-circular heat insulating members are to be mounted (attached)
to a pipe, the urethane foam agent is charged to the joining portion
between the semi-cylindrical heat insulating members for joining these
15 semi-cylindrical heat insulating members to each other.

 Further, when the semi-cylindrical heat insulating members are
to be detached from the pipe, the detachment requires cutting of
appropriate portions of the pair of semi-cylindrical heat insulating
members joined to each other via the urethane foam agent.

20 **[0006]**

 Therefore, attachment of the semi-cylindrical heat insulating
members is accompanied by a troublesome charging operation of the
urethane foam agent. Thus, the attaching operation of the semi-
cylindrical heat insulating members is troublesome. The detaching
25 operation of the semi-cylindrical heat insulating members is also
troublesome, since this detaching operation requires cutting of the semi-
cylindrical heat insulating members which are provided with a significant
thickness for the purpose of favorable heat insulation.

 Moreover, the detachment by way of cutting the semi-cylindrical
30 heat insulating members makes reuse of the semi-cylindrical heat
insulating members difficult.

[0007]

 Incidentally, in order to facilitate the attaching and detaching
operations of the semi-circular heat insulating member and to enable
35 reuse of the semi-circular heat insulating member after its detachment,
it is conceivable not to bond the connecting portions of the pair of semi-

circular heat insulating members with the urethane foam agent. In this case, however, as a gap is formed between the pair of semi-circular heat insulating members, there arises the problem of effective heat insulation of the pipe being not possible at this gap portion.

5 [0008]

The present invention has been made in view of the above-described state of the art. Its object is to provide a method of attaching a heat insulating member that provides effective heat insulation of a heat insulation object and that yet makes it possible to facilitate an attaching operation of the heat insulating member.

10 A further object of the present invention is to provide a method of detaching a heat insulating member that makes it possible to facilitate a detaching operation of the heat insulating member and that also allows reuse of the heat insulating member.

15

Solutions

[0009]

According to the present invention, there is provided a method of attaching a heat insulation structure comprising a plurality of heat insulating members juxtaposed along a circumferential direction of a cylindrical or hollow spherical heat insulation object to be cooled by a cold fluid for covering an outer circumference of the heat insulation object for its heat insulation, the method being characterized in that:

20 at an end face of a heat insulating member opposed to a further heat insulating member adjacent thereto in the circumferential direction, a receded groove portion receded in the circumferential direction from the opposed end face is preformed in a form of a groove along a longitudinal direction of the heat insulating member and including, on the back side thereof along the circumferential direction, a wide portion which has a greater width than an opening width of an entrance portion along a thickness direction of the heat insulating member;

25 a connecting member elongate along the longitudinal direction of the heat insulating member is preformed to include, along the circumferential direction, a pair of engagement portions engageable with the receded groove portions of the respective heat insulating members adjacent in the circumferential direction; and

30

35

when the heat insulating members are to be attached to the heat insulation object, the method carries out one after another a disposing step of disposing the heat insulating members adjacent in the circumferential direction on an outer circumferential portion of the heat insulation object with the opposed end faces thereof being placed in abutment against each other, and an inserting step of inserting the connecting member to the receded groove portions of the respective heat insulating members adjacent to each other.

[0010]

Namely, at an end face of the heat insulating member adjacent in the circumferential direction of the heat insulation object, a receded groove portion receded in the circumferential direction from the opposed end face is preformed in a form of a groove along a longitudinal direction of the heat insulating member and including, on the back side thereof along the circumferential direction, a wide portion which has a greater width than an opening width of an entrance portion along a thickness direction of the heat insulating member.

Further, a connecting member elongate along the longitudinal direction of the heat insulating member is preformed to include, along the circumferential direction, a pair of engagement portions engageable with the receded groove portions of the respective adjacent heat insulating members adjacent in the circumferential direction of the heat insulation object.

[0011]

And, when the heat insulating members are to be attached to the heat insulation object, a disposing step of disposing the heat insulating members adjacent in the circumferential direction on an outer circumferential portion of the heat insulation object with the opposed end faces thereof being placed in abutment against each other, and an inserting step of inserting the connecting member to the receded groove portions of the respective heat insulating members adjacent to each other are carried out one after another.

[0012]

When the heat insulating members are attached to the outer circumferential portion of the heat insulation object, the heat insulating members adjacent each other in the circumferential direction of the heat

insulation object are connected via the connecting member and also the connecting member is disposed between the opposed end faces of the adjacent heat insulating members. Thus, formation of a gap between the adjacent heat insulating members can be avoided, so that the heat insulation object can be heat-insulated in an effective manner.

[0013]

Moreover, since attachment of the heat insulating members to the heat insulation object is effected by insertion of the connecting member to the receded groove portions of the heat insulating members disposed on the outer circumferential portion of the heat insulation object, it is possible to facilitate the attaching operation of the heat insulating members.

[0014]

In summary, the method of attaching a heat insulation structure according to the present invention allows effective heat insulation of a heat insulation object, and allows, moreover, facilitation of the attaching operation of the heat insulating members.

[0015]

According to a further characterizing feature of the method attaching a heat insulation structure of the present invention:

the heat insulation object comprises a cylindrical tube in which the cold fluid flows; and

the heat insulating member is in the form of a plate extending along an axial direction of the cylindrical tube and also in the form of an arc-shaped curved plate as seen in the axial direction.

[0016]

Namely, as the plurality of heat insulating members each in the form of a plate extending along an axial direction of the cylindrical tube and an arc-shaped curved plate as seen in the axial direction are juxtaposed on the outer circumferential portion of the cylindrical tube as the heat insulation object, the entire outer circumferential portion of the cylindrical tube can be covered by the plurality of heat insulating members appropriately.

Therefore, since the entire outer circumferential portion of the cylindrical tube can be covered by the plurality of heat insulating members appropriately, effective heat insulation of the cylindrical tube is

made possible.

[0017]

In short, according to the further characterizing feature of the method of attaching a heat insulation structure, the cylindrical tube as a heat insulation object can be heat-insulated appropriately.

[0018]

According to a still further characterizing feature of the method of attaching a heat insulation structure of the present invention:

three or more said heat insulating members are juxtaposed along the circumferential direction; and

when the heat insulating members are to be attached to the cylindrical tube, for some of the plurality of heat insulating members, the method carries out a pre-assembling step in which the connecting member is inserted to the receded groove portions of the respective heat insulating members adjacent in the circumferential direction, with the opposed end faces thereof being placed in abutment against each other, and the group of the heat insulating members assembled at the pre-assembling step is disposed at the disposing step.

[0019]

Namely, in case the cylindrical tube has a large diameter for instance, three or more said heat insulating members will be juxtaposed along the circumferential direction.

And, in this case of three or more said heat insulating members being juxtaposed along the circumferential direction, prior to attachment of the heat insulating members to the cylindrical tube, for some of the plurality of heat insulating members, a pre-assembling step is carried out in which the connecting member is inserted to the receded groove portions of the respective heat insulating members adjacent in the circumferential direction, with the opposed end faces thereof being placed in abutment against each other.

[0020]

Incidentally, the pre-assembling step can be realized by such a simple operation in which the heat insulating members adjacent in the circumferential direction are first placed erect on a mounting face such as a ground surface and then the connecting member is inserted from above the receded groove portions of these placed heat insulating members.

[0021]

Therefore, the three or more heat insulating members juxtaposed along the circumferential direction will include a group of heat insulating members connected in advance via the connecting member at the pre-assembling step. Thus, since the three or more heat insulating members can be juxtaposed along the circumferential direction by disposing this group of heat insulating members on the outer circumferential portion of the cylindrical tube at the disposing step, the attaching operation can be further facilitated.

[0022]

Namely, thanks to the presence of the group of heat insulation members connected in advance via the connecting member at the pre-assembling step, with disposing this group on the outer circumferential portion of the cylindrical tube, by attaching the three or more heat insulating members juxtaposed along the circumferential direction on the outer circumferential portion, it becomes possible to facilitate the attaching operation for attaching three or more heat insulating members in juxtaposition along the circumferential direction on the outer circumferential portion of the cylindrical tube.

[0023]

In short, according to the still further characterizing feature of the method of attaching a heat insulation structure of the present invention, it becomes possible to facilitate the attaching operation for attaching three or more heat insulation members in juxtaposition along the circumferential direction.

[0024]

According to a still further characterizing feature of the method of attaching a heat insulation structure of the present invention:

as the heat insulating members, there are provided a plurality of kinds of heat insulating members having curvature radii different from each other in order to form a plurality of heat insulation layers in a radial direction of the cylindrical tube, with a further heat insulating member being attached to an outer circumferential portion of the heat insulating member attached in advance; and

when the heat insulating members are to be attached to the heat insulation object, the plurality of kinds of heat insulating members are

attached in such a manner that the smaller the curvature radii of the heat insulating members, the earlier the heat insulating members are attached.

[0025]

5 Namely, there are provided a plurality of kinds of heat insulating members having curvature radii different from each other in order to form a plurality of heat insulation layers in the radial direction of the cylindrical tube, with a further heat insulating member being attached to an outer circumferential portion of the heat insulating member attached
10 in advance.

[0026]

 And, when the heat insulating members are to be attached to the heat insulation object, the plurality of kinds of heat insulating members are attached in such a manner that the smaller the curvature radii of the
15 heat insulating members, the earlier the heat insulating members are attached, thus forming the plurality of heat insulation layers.

 Therefore, as the cylindrical tube can be covered by the plurality of heat insulation layers, even more appropriate heat insulation of the cylindrical tube is made possible.

20 [0027]

 In short, according to the still further characterizing feature of the method of attaching a heat insulation structure of the present invention, even more effective heat insulation of the cylindrical tube is made possible.

25 [0028]

 According to a still further characterizing feature of the method of attaching a heat insulation structure of the present invention:

 in at least some of the inner side heat insulation layers included in the plurality of heat insulation layers, the receded groove portion is not
30 formed and the heat insulating member is disposed without insertion of the connecting member to the receded groove portion.

[0029]

 Namely, when the cylindrical tube is to be covered by the plurality of heat insulation layers, in at least some of the inner side heat insulation layers included in the plurality of heat insulation layers, the receded
35 groove portion is not formed and the heat insulating member is disposed

without insertion of the connecting member to the receded groove portion.

That is, a heat insulation layer on the inner side of the plurality of heat insulation layers is covered by a heat insulation layer on the outer side, thus being held under an appropriate posture. In view of this, in at least some of the inner side heat insulation layers included in the plurality of heat insulation layers, the receded groove portion is not formed and the heat insulating member is disposed without insertion of the connecting member to the receded groove portion.

[0030]

Therefore, since the receded groove portion is not formed and the connecting member is not inserted to the receded groove portion for at least some of the inner side heat insulation layers of the plurality of heat insulation layers, the trouble of forming the receded groove portion can be omitted and also the consumption amount of the connecting member can be reduced, whereby the simplification and cost reduction of the heat insulation structure are made possible.

[0031]

In short, according to the still further characterizing feature of the method of attaching a heat insulation structure of the present invention, the simplification and cost reduction of the heat insulation structure are made possible.

[0032]

According to a still further characterizing feature of the method of attaching a heat insulation structure of the present invention:

the heat insulating members are disposed in such a manner that opposing portions at which the opposed end faces of the heat insulating members adjacent in the circumferential direction are placed in abutment against each other are made different in phase in the circumferential direction in the heat insulation layers adjacent in the radial direction of the plurality of heat insulation layers.

[0033]

Namely, when the cylindrical tube is to be covered by the plurality of heat insulation layers, the heat insulating members are disposed in such a manner that opposing portions at which the opposed end faces of the heat insulating members adjacent in the circumferential direction are placed in abutment against each other are made different in phase in the

circumferential direction in the heat insulation layers adjacent in the radial direction of the plurality of heat insulation layers.

[0034]

Therefore, for the heat insulation layers adjacent in the radial direction of the plurality of heat insulation layers, opposing portions at which the opposed end faces of the heat insulating members adjacent in the circumferential direction are placed in abutment against each other are made different in phase in the circumferential direction. With this, at the opposing portion of the circumferentially adjacent heat insulating members, a portion other than the opposing portion of the heat insulating member of further heat insulation layer will be located, so that the heat insulation performance at the opposing portion of the heat insulating members adjacent in the circumferential direction can be ensured appropriately.

[0035]

Namely, in the heat insulation layers adjacent in the radial direction of the plurality of heat insulation layers, if the opposing portions at which the opposed end faces of the heat insulating members adjacent in the circumferential direction are placed in abutment against each other were made same in phase in the circumferential direction, this may result in deterioration in the heat insulation performance at the opposing portion of the heat insulating members adjacent in the circumferential direction. In contrast, with the above arrangement in which for the heat insulation layers adjacent in the radial direction of the plurality of heat insulation layers, opposing portions at which the opposed end faces of the heat insulating members adjacent in the circumferential direction are placed in abutment against each other are made different in phase in the circumferential direction, the heat insulation performance at the opposing portion of the heat insulating members adjacent in the circumferential direction can be ensured appropriately.

[0036]

In short, according to the still further characterizing feature of the method of attaching a heat insulation structure of the present invention, the heat insulation performance at the opposing portion of the heat insulating members adjacent in the circumferential direction can be ensured appropriately.

[0037]

According to a still further characterizing feature of the method of attaching a heat insulation structure of the present invention:

5 the receded groove portion includes a circumferentially receded portion which is receded from the entrance portion along the circumferential direction and a radially receded portion which is receded from an end portion of the circumferentially receded portion as the wide portion toward the radially outer side;

10 when the connecting member is not inserted, a portion in the end face located on the radially inner side of the receded groove portion is cut away to form a cutaway portion, and at a radially outer portion of the cutaway portion, there is formed a retaining receded portion which is receded radially outwards;

15 a coupling member elongate along a longitudinal direction of the heat insulating member is preformed to include, along the circumferential direction, a pair of retaining protruding portions engageable with the retaining receded portion of the respective heat insulating member adjacent in the circumferential direction; and

20 when the heat insulating members adjacent in the circumferential direction are to be disposed with the opposed end faces thereof being placed in abutment against each other, the retaining receded portion is engaged with the coupling member disposed in advance.

[0038]

25 Namely, the receded groove portion is formed to include a circumferentially receded portion which is receded from the entrance portion along the circumferential direction and a radially receded portion which is receded from an end portion of the circumferentially receded portion as the wide portion toward the radially outer side.

[0039]

30 And, when the connecting member is not to be inserted due to e.g. presence of a flange for connecting of the cylindrical tube, in other words, in the case of insertion of the connecting member being not possible, a portion in the end face located on the radially inner side of the receded groove portion is cut away, and at a radially outer portion of the cutaway portion thus formed, there is formed a retaining receded portion which is
35 receded radially outwards.

In addition, a coupling member elongate along a longitudinal direction of the heat insulating member is preformed to include, along the circumferential direction, a pair of retaining protruding portions engageable with the retaining receded portion of the respective heat insulating member adjacent in the circumferential direction.

[0040]

Therefore, when the connecting member is not inserted, for attaching the heat insulating members adjacent in the circumferential direction with the opposed end faces thereof being placed in abutment against each other, the retaining receded portion of the heat insulating member will be engaged with the coupling member disposed in advance, so that the heat insulating members adjacent in the circumferential direction will be attached with the opposed end faces thereof being placed in abutment against each other.

Namely, even when the insertion of the connecting member is not possible due to e.g. presence of a flange for connection of the cylindrical tube, the heat insulation of the cylindrical tube is possible by attaching the heat insulating members with the retaining receded portions formed therein to the outer circumferential portion of the cylindrical tube.

[0041]

In short, according to the still further characterizing feature of the method of attaching a heat insulation structure of the present invention, even when insertion of the connecting member is not possible, the heat insulation of the cylindrical tube is possible by attaching the heat insulating members to the outer circumferential portion of the cylindrical tube with utilization of the heat insulating members having the retaining receded portions formed therein.

[0042]

According to a still further characterizing feature of the method of attaching a heat insulation structure of the present invention:

prior to the inserting step, the method carries out a shaping step in which the connecting member or a shaping tool is inserted to the respective receded groove portions of the adjacent heat insulating members; and

the shaping tool has a cross sectional shape which is same as that of the connecting member and a longer length than the connecting

member and at least surface of the shaping tool is formed harder than the surface of the connecting member.

[0043]

5 Namely, prior to the execution of the inserting step of inserting the connecting member to the respective receded groove portions of the adjacent heat insulating members, a shaping step is carried out in which the connecting member or a shaping tool is inserted to the respective receded groove portions of the adjacent heat insulating members. With this, the insertion of the connecting member to the respective receded groove portions of the adjacent heat insulating members can be carried out in a favorable manner.

10 The shaping tool has a cross sectional shape which is same as that of the connecting member and a longer length than the connecting member and at least the surface of this shaping tool is formed harder than the surface of the connecting member.

[0044]

20 Namely, the insertion of the connecting member to the respective receded groove portion of the adjacent heat insulating members may be difficult due to the shape of the receded groove portion being slightly different from its normal shape because of a manufacturing error or the like. Then, with execution of the shaping step described above, the insertion of the connecting member to the respective receded groove portions of the adjacent heat insulating members can be carried out smoothly.

25 **[0045]**

Incidentally, the shaping step may be always carried out prior to the execution of the inserting step. Alternatively, the shaping step may be carried out when the insertion of the connecting member to the respective receded groove portion of the adjacent heat insulating members has proven difficult when the inserting step is carried out.

[0046]

30 In short, according to the still further characterizing feature of the method of attaching a heat insulation structure of the present invention, the insertion of the connecting member to the respective receded groove portions of the adjacent heat insulating members can be carried out smoothly.

[0047]

According to a detaching method of a heat insulation structure relating to the present invention, there is provided a method of detaching a heat insulation structure comprising a plurality of heat insulating members juxtaposed along a circumferential direction of a cylindrical or hollow spherical heat insulation object to be cooled by a cold fluid for covering an outer circumference of the heat insulation object for its heat insulation, the method being characterized in that:

at an end face of a heat insulating member opposed to a further heat insulating member adjacent thereto in the circumferential direction, a receded groove portion receded in the circumferential direction from the opposed end face is preformed in a form of a groove along a longitudinal direction of the heat insulating member and including, on the back side thereof along the circumferential direction, a wide portion which has a greater width than an opening width of an entrance portion along a thickness direction of the heat insulating member;

a connecting member elongate along the longitudinal direction of the heat insulating member is preformed to include, along the circumferential direction, a pair of engagement portions engageable with the receded groove portions of the respective heat insulating members adjacent in the circumferential direction; and

the heat insulating members adjacent in the circumferential direction are disposed on an outer circumferential portion of the heat insulation object with the opposed end faces thereof being placed in abutment against each other and with the connecting member being inserted to the receded groove portions of the respective heat insulating members adjacent thereto; and

when the heat insulating members are to be detached from the heat insulation object, the method carries out one after another a cutting step of cutting a portion of the connecting member used for connecting the pair of engagement portions along the opposed end faces and a detaching step of detaching the respective heat insulating members from the heat insulation object adjacent thereto.

[0048]

Namely, at an end face of a heat insulating member opposed to a further heat insulating member adjacent thereto in the circumferential

direction, a receded groove portion receded in the circumferential direction from the opposed end face is preformed in a form of a groove along a longitudinal direction of the heat insulating member and including, on the back side thereof along the circumferential direction, a
5 wide portion which has a greater width than an opening width of an entrance portion along a thickness direction of the heat insulating member.

Further, a connecting member elongate along the longitudinal direction of the heat insulating member is preformed to include, along the
10 circumferential direction, a pair of engagement portions engageable with the receded groove portions of the respective heat insulating members adjacent in the circumferential direction of the heat insulation object.

[0049]

Referring to the mode of attaching the heat insulating members
15 to the heat insulation object, the heat insulating members adjacent in the circumferential direction are disposed on the outer circumferential portion of the heat insulation object, with the opposed end faces thereof being placed in abutment against each other and with the connecting member being inserted to the receded groove portions of the adjacent heat
20 insulating members.

Namely, the heat insulation object is heat insulated by the heat insulating members which are disposed on the outer circumferential portion of the heat insulation object, with the opposed end faces thereof being placed in abutment against each other and with the connecting
25 member being inserted to the receded groove portions of the adjacent heat insulating members.

[0050]

And, when the heat insulating members are to be detached from the heat insulation object, a cutting step of cutting a portion of the
30 connecting member used for connecting the pair of engagement portions along the opposed end faces and a detaching step of detaching the heat insulating members from the heat insulation object are carried out one after another.

[0051]

35 The cutting step may be a step in which a cutter is inserted between the opposed end faces of the heat insulating members adjacent

in the circumferential direction and then moved along the opposed end faces to cut the portion of the connecting member connecting the pair of engagement portions along the opposed end faces. Thus, the connecting member which is thinner than the heat insulating member can be easily cut by the cutter and also the cutter can be guided by the opposed end faces, so that the cutter can be moved in a favorable manner along the opposed end faces, so that the cutting step can be carried out easily.

[0052]

And, when the portion of the connecting member used for connecting the pair of engagement portions along the opposed end faces is cut, the connecting member is divided into two parts, so that the connection of the circumferentially adjacent heat insulating members by the connecting member is released. Thus, the subsequent detaching step of detaching the heat insulating members from the heat insulation object can be carried out easily.

[0053]

In the heat insulating member detached from the heat insulation object, the connecting member portion which was cut will remain. However, this remaining portion of the connecting member can be easily removed from the heat insulating member without damaging the heat insulating member by e.g. pressing it out through the entrance portion of the receded groove portion by means of a pressing tool inserted into the receded groove portion. As a result, the heat insulating member can be reused.

[0054]

In summary, according to the method of detaching a heat insulation structure of the present invention, the handling operation of the heat insulating members can be facilitated and reuse of the heat insulating members is made possible also.

BRIEF DESCRIPTION OF THE DRAWINGS

[0055]

Fig. 1 is a side view in vertical section showing attached states of heat insulating members,

Fig. 2 is a cutaway perspective view showing attached states of the heat insulating members and an end portion heat insulating member,

Fig. 3 is a cutaway perspective view showing attached states of the heat insulating members,

Fig.4 is a section view taken along IV-IV line in Fig. 1,

Fig. 5 is an exploded perspective view showing relation between a connecting member and the heat insulating members,

Fig. 6 a front view showing a receded groove portion of the heat insulating member,

Fig. 7 is a front view showing the connecting member,

Fig. 8 is a section view taken along VIII-VIII line in Fig. 1,

Fig. 9 is a front view showing attachment procedure of the end portion heat insulating member,

Fig. 10 is a partially enlarged perspective view of a coupling member,

Fig. 11 is a perspective view showing relation between the connecting member and a shaping tool,

Fig. 12 is a front view showing detachment procedure of the heat insulating members,

Fig. 13 is a front view showing attached state of heat insulating members in a further embodiment,

Fig. 14 is a front view showing attached state of heat insulating members in a further embodiment,

Fig. 15 is a front view showing attached state of an end portion heat insulating member in a still further embodiment,

Fig. 16 is a front view showing a further mode of a receded groove portion,

Fig. 17 is a front view showing a further mode of a receded groove portion, and

Fig. 18 is a front view showing a further mode of a connecting member.

MODES OF EMBODYING THE INVENTION

[0056]

[Embodiments]

Next, embodiments of the present invention will be explained with reference to the accompanying drawings.

(General Configuration of Heat Insulation Structure)

As shown in Fig. 1 and Fig. 2, there is provided a cylindrical tube 1 in the form of a cylinder tube (an example of "heat insulation object") in which cold fluid such as LNG, LPG, etc. is caused to flow. On the outer circumferential portion of this cylindrical tube 1, a plurality of heat insulating members P formed of urethane foam made by foaming urethane resin are attached in juxtaposition along the circumferential direction and the axial direction of the cylindrical tube 1.

[0057]

Each one of the plurality of heat insulating members P is in a form of a plate having a predetermined length extending along an axial direction of the cylindrical tube 1 and in a form of arcuate-shaped curved plate as seen in the axial direction of the cylindrical tube 1.

Namely, the heat insulating member P is made by cutting a base material which is in an arcuate form (semi-circular form in the present embodiment) along the circumferential direction of the cylindrical tube 1 and having a predetermined thickness in the radial direction of the cylindrical tube 1 and having also a long length in the axial direction of the cylindrical tube 1 to the predetermined length in the axial direction of the cylindrical tube 1.

[0058]

As shown in Fig. 5, in the following discussion, the radially outer side face of the heat insulating member P is defined as an outer face 3 and the radially inner side face thereof is defined as an inner face 4, the opposed faces in the circumferential direction are defined as end faces 5 and the opposed faces in the axial direction are defined as side faces 6, respectively.

Incidentally, the reason why the faces at the opposed ends in the circumferential direction are referred to as "opposed end faces 5" is that the heat insulating members P are disposed with the opposed circumferential end faces of the pair of heat insulating members P adjacent in the circumferential direction of the cylindrical tube 1 being placed in abutment against each other.

[0059]

In the instant embodiment, as the heat insulating members P, there are provided a plurality of kinds of heat insulating members P having different curvature radii in order to form a plurality of heat

insulation layers (three layers in this embodiment) in the radial direction of the cylindrical tube 1 with a further heat insulating member P being attached on the outer circumferential portion of one heat insulating member P attached in advance. And, the heat insulating members P are attached to form three layers of heat insulation layers along the radial direction of the cylindrical tube 1.

Namely, as the heat insulating members P having different curvature radii (three kinds in this embodiment), there are provided a large-diameter heat insulating member PL having the greatest diameter, an intermediate-diameter heat insulating member PM having an intermediate diameter and a small-diameter heat insulating member PS having the smallest diameter (see Fig. 3 and Fig. 4).

[0060]

Incidentally, under the superposed or stacked state of the heat insulating members P, the outer face 3 of the large-diameter heat insulating member PL is located on the outermost side, the inner face 4 of the large-diameter heat insulating member PL and the outer face 3 of the intermediate-diameter heat insulating member PM are disposed side by side with a same diameter, the inner face 4 of the intermediate-diameter heat insulating member PM and the outer face 3 of the small-diameter heat insulating member PS are disposed side by side with a same diameter, and the inner face 4 of the small-diameter heat insulating member PS is disposed side by side with the outer circumferential face of the cylindrical tube 1 with a same diameter, respectively.

[0061]

As shown in Fig. 1, at opposed end portions of the cylindrical tube 1, flanges F are provided. As these flanges F are coupled with flanges of adjacent cylindrical tubes 1 with using bolts, there is formed a flow passage through which the cold fluid is caused to flow.

The plurality of heat insulating members P will be attached one after another from the one end portion (the left end portion in Fig. 1) to the other end portion (the right end portion in Fig. 1) of the cylindrical tube 1, thus being attached at the portion adjacent one end portion of the cylindrical tube 1, at the portion adjacent the other end portion of the cylindrical tube 1 and the portion(s) corresponding to the portion therebetween.

[0062]

Referring to the mode of disposing the heat insulating members P in juxtaposition in the axial direction of the cylindrical tube 1, the mode of disposing the small-diameter heat insulating members PS and the mode of disposing the large-diameter heat insulating members PL having the largest diameter are same; whereas, the mode of disposing the intermediate-diameter heat insulating members PM is different.

Namely, the small-diameter heat insulating member PS, the intermediate-diameter heat insulating member PM and the large-diameter heat insulating member PL are formed to have a basic length (e.g. 1 m) along the axial direction of the cylindrical tube 1.

[0063]

And, respecting the small-diameter heat insulating members PS and the large-diameter heat insulating members PL, these will be arranged such that the heat insulating members P having the basic length are disposed side by side from one end portion toward the other end portion of the cylindrical tube 1. Whereas, respecting the intermediate-diameter heat insulating members PM, these will be arranged such that after heat insulating members P having a half the basic length (e.g. 0.5 m) are arranged at the one end portion of the cylindrical tube 1, the heat insulating members P having the basic length will be arranged one after another toward the other end portion of the cylindrical tube 1.

[0064]

At the portion adjacent the other end portion of the cylindrical tube 1, the axial lengths of the small-diameter heat insulating members PS, the intermediate-diameter heat insulating members PM and the large-diameter heat insulating members PL will be determined appropriately in correspondence with the axial length of the cylindrical tube 1.

However, the axial lengths of the small-diameter heat insulating member PS, the intermediate-diameter heat insulating member PM and the large-diameter heat insulating member PL adjacent the other end portion of the cylindrical tube 1 are configured to exceed 1 m, in order to form a space for attachment of a connecting member 7 (see Fig. 5) which will be described later.

[0065]

Further, respecting the intermediate-diameter heat insulating member PM, as the intermediate-diameter heat insulating member PM having the half the basic length (e.g. 0.5 m) is to be disposed at the portion adjacent the one end portion of the cylindrical tube 1, at the portion adjacent the other end portion of the cylindrical tube 1, the axial length of the intermediate-diameter heat insulating member PM is made different from the axial lengths of the small-diameter heat insulating member PS and the large-diameter heat insulating member PL.

In the instant embodiment, the axial length of the intermediate-diameter heat insulating member PM is set to a length which is a sum of the axial length of the small-diameter heat insulating member PS and the large-diameter heat insulating member PL and the half of the basic length (e.g. 0.5 m).

[0066]

Moreover, at the intermediate portions excluding the portion adjacent the one end portion of the cylindrical tube 1 and the portion adjacent the other end portion of the cylindrical tube 1, the arrangement (to be referred to simply as "basic attachment arrangement" hereinafter) for attaching the heat insulating members P in juxtaposition along the circumferential direction of the cylindrical tube 1 remains the same, but the attachment arrangement (to be referred to simply as "end portion attachment arrangement" hereinafter) of attaching the heat insulating members P in juxtaposition along the circumferential direction of the cylindrical tube 1 at the portion adjacent the other end portion of the cylindrical tube 1 differs from the above-described basic attachment arrangement.

[0067]

Namely, in the section distant by greater than 1 m from the flange F from the one end portion of the cylindrical tube 1, the heat insulating members P will be attached by the basic attachment arrangement using a connecting member 7 to be described later, whereas at the portions adjacent the other end portions of the cylindrical tube 1, the heat insulating members P will be attached by the end portion attachment arrangement using a coupling member B to be described later. Next, the basic attachment arrangement and the end portion attachment

arrangement will be explained one after another.

[0068]

Incidentally, at the portion between the flange F of the cylindrical tube 1 and the heat insulating member P, there is charged heat insulating material D such as glass wool. And, at the portion corresponding to the upper portion of the flange F of the cylindrical tube 1, with an arrangement similar to the basic attachment arrangement, arc-shaped heat insulating members Q for flange are disposed in two layers.

[0069]

10 (Basic Attachment Arrangement)

As shown in Fig. 6, at an end face of the heat insulating member P opposed to the further heat insulating member P adjacent thereto in the circumferential direction, a receded groove portion 8 receded in the circumferential direction from the opposed end face 5 is preformed in a form of a groove along a longitudinal direction of the heat insulating member P and including, on the back side thereof along the circumferential direction, a wide portion 8w which has a greater width than an opening width Hn of an entrance portion 8n along a thickness direction of the heat insulating member P. Namely, in this embodiment, the receded groove portion 8 is formed to present an L-shape.

Incidentally, the thickness direction of the heat insulating member P corresponds to the radial direction of the cylindrical tube 1, thus, the thickness direction will be referred to as the "radial direction" hereinafter.

25 Further, the longitudinal direction of the heat insulating member P is the direction corresponding to the axial direction of the cylindrical tube 1.

[0070]

30 In the instant embodiment, the receded groove portion 8 is formed to include a circumferentially receded portion 8u which is receded from the entrance portion 8n linearly along the circumferential direction and a radially receded portion 8a which is receded linearly toward the radially outer side from an end portion of the circumferentially receded portion 8u to form the wide portion 8w. Namely, in this embodiment, the receded groove portion 8 is formed to present an L-shape as a whole.

Incidentally, in the above discussion, the circumferential direction

of the cylindrical tube 1 means, to be more exact, the tangential direction of the opposed end face 5 of the heat insulating member P. This will apply to the following discussion also.

[0071]

Incidentally, as for the shape of the receded groove portion 8, in place of the L-shape described above, various other shapes will be possible such as bending the circumferentially receded portion 8u and the radially receded portion 8a together to present a C-shape as a whole. Incidentally, other modes of the receded groove portion 8 will be described later.

[0072]

As shown in Fig. 5 and Fig. 7, the connecting member 7 elongate along a longitudinal direction of the heat insulating member P is preformed to include, along the circumferential direction, a main body portion 7A extending along the circumferential direction and a pair of engagement portions 7a engageable with the receded groove portions 8 of the respective heat insulating members P adjacent in the circumferential direction.

Incidentally, the length of the connecting member 7 is set equal to the axial length of the heat insulating member P and the connecting member 7 is formed of urethane resin like the heat insulating member P.

[0073]

Therefore, in the basic attachment arrangement, as shown in Fig. 4, the arc-shaped (semi-circular in this embodiment) heat insulating members P divided into a plurality (two in this embodiment) in the circumferential direction of the cylindrical tube 1 are disposed with the opposed end faces 5 thereof being placed in abutment against each other and at each one of the opposed portions of the plurality (two in this embodiment) of opposed end faces 5 located in the circumferential direction of the cylindrical tube 1, by connecting the opposed end portions of an adjacent pair of heat insulating members P to each other via the connecting member 7 elongate along the axial direction of the cylindrical tube 1, the heat insulating members P are attached on the outer circumferential portion of the cylindrical tube 1.

[0074]

Namely, in the basic attachment arrangement, when the heat

insulating members P are to be attached to the outer circumferential portion of the cylindrical tube 1, as shown in Fig. 4, there are carried out one after another a disposing step of disposing the heat insulating members P to be adjacent in the circumferential direction on the outer circumferential portion of the cylindrical tube 1 with the opposed end faces thereof being placed in abutment against each other and an inserting step of inserting the connecting member 7 to the respective receded groove portions 8 of the adjacent heat insulating members P.

Further, when the heat insulating members P are to be attached to the outer circumferential portion of the cylindrical tube 1, the plurality of kinds of heat insulating members P will be attached in such a manner that the smaller the curvature radius of the heat insulating member P, the earlier its attachment.

[0075]

More particularly, firstly, the small-diameter heat insulating members PS will be attached to the outer circumferential face of the cylindrical tube 1. Next, the intermediate-diameter heat insulating members PM will be attached to the outer circumferential faces of the small-diameter heat insulating members PS. Lastly, the large-diameter heat insulating members PL will be attached to the outer circumferential faces of the intermediate-diameter heat insulating members PM.

Under the above-described state in which the small-diameter heat insulating members PS, the intermediate-diameter heat insulating members PM and the large-diameter heat insulating members PL have been attached, on the outer circumferential portion of the cylindrical tube 1, a plurality (three) of heat insulation layers provided in the cylindrical form and with the different diameters by the plurality of arc-shaped (two semi-circular) heat insulating members P connected with each other via the connecting members 7.

[0076]

Also, the small-diameter heat insulating members PS, the intermediate-diameter heat insulating members PM and the large-diameter heat insulating members PL are attached in such a manner that the opposed portions where the end faces of the small-diameter heat insulating members PS are placed in abutment against each other and the opposed portion where the end faces of the intermediate-diameter

heat insulating members PM are placed in abutment against each other have their phases 90 degrees made different from each other in the circumferential direction of the cylindrical tube 1 and similarly the opposed portions where the end faces of the intermediate-diameter heat insulating members PM are placed in abutment against each other and the opposed portion where the end faces of the large-diameter heat insulating members PL are placed in abutment against each other have their phases 90 degrees made different from each other in the circumferential direction of the cylindrical tube 1.

[0077]

Namely, when the heat insulating members P are to be attached to the outer circumferential portion of the cylindrical tube 1, the heat insulating members P will be attached in such a manner that opposed portions at which the opposed end faces of the heat insulating members P adjacent in the circumferential direction are placed in abutment against each other are made different in phase in the circumferential direction in the heat insulation layers adjacent in the radial direction of the plurality of (three) heat insulation layers.

[0078]

Incidentally, though not shown, a sheet is attached to cover the outer circumferences of the stacked heat insulating members P, thus providing reinforcement and heat insulation performance improvement of the stacked heat insulating members P.

[0079]

(End Portion Attachment Arrangement)

In the end portion attachment arrangement, as shown in Fig. 8, the above-described semi-circular heat insulating members P halved in the circumferential direction of the cylindrical tube 1 are used as the end portion heat insulating members PA halved in the circumferential direction of the cylindrical tube 1.

Namely, as shown in Fig. 9, when the connecting member 7 is not inserted, a portion of the end face portion of the heat insulating member P located on the radially inner side of the receded groove portion 8 is cut away, thus forming a retaining receded portion V receded to the radially outer side at a radially outer side portion of this cut-away portion J.

That is, the retaining receded portion V receded to the radially

outer side is formed by utilizing the radially receded portion 8a of the receded groove portion 8.

[0080]

As shown in Fig. 10, a coupling member B elongate along the longitudinal direction of the heat insulating member P is provided in advance, along the circumferential direction, with a pair of retaining protruding portions Ba engageable with the retaining receded portions V of the respective heat insulating members P adjacent in the circumferential direction.

Incidentally, the length of the coupling member B is set equal to the axial length of the heat insulating member P and also the coupling member B is formed of urethan resin, like the heat insulating member P.

[0081]

And, when the heat insulating members P (end portion heat insulating members PA) adjacent in the circumferential direction are to be disposed with the opposed end faces 5 thereof being placed in abutment against each other, with slight elastic deformation of the heat insulating members P (end portion heat insulating members PA), the retaining receded portions V will be brought into engagement with the coupling member B disposed in advance.

[0082]

More particularly, firstly, while the retaining receded portions V are being brought into engagement with the coupling member B disposed on the outer circumferential face of the cylindrical tube 1, the small-diameter heat insulating member PS (end portion heat insulating member PA) will be attached to the outer circumferential face of the cylindrical tube 1. Next, while the retaining receded portion V is being brought into engagement with the coupling member B disposed on the outer face 3 of the small-diameter heat insulating member PS, the intermediate-diameter heat insulating member PM (end portion heat insulating member PA) will be attached to the outer face 3 of the small-diameter heat insulating member PS. Lastly, while the retaining receded portion V is being brought into engagement with the coupling member B disposed on the outer face 3 of the intermediate-diameter heat insulating member PM, the large-diameter heat insulating member PL (end portion heat insulating member PA) will be attached to the outer

face 3 of the intermediate-diameter heat insulating member PM.

[0083]

Incidentally, when the coupling member B is to be disposed on the outer circumferential face of the cylindrical tube 1 or on the outer face 3 of the heat insulating member P stacked in advance, the bottom face of the coupling member B which will come into contact with the outer circumferential face of the cylindrical tube 1 or the outer face 3 of the heat insulating member P will be shaved into a shape conforming to the outer circumferential face of the cylindrical tube 1 or the outer face 3 of the heat insulating member P.

Further, when the coupling member B is to be disposed on the outer circumferential face of the cylindrical tube 1 or on the outer face 3 of the heat insulating member P stacked in advance, advantageously, the coupling member B may be temporarily fixed with using sizing agent in case the disposing position of the coupling member B happens to be located e.g. at a lateral position or a lower position in outer circumferential face of the cylindrical tube 1 or on the outer face 3 of the heat insulating member P stacked in advance.

[0084]

In this way, when the small-diameter heat insulating member PS, the intermediate-diameter heat insulating member PM and the large-diameter heat insulating member PL have been attached as the end portion heat insulating members PA, on the outer circumferential portion of the cylindrical tube 1, a plurality (three) of heat insulation layers will be formed in the cylindrical form and with the different diameters by the plurality of arc-shaped (two semi-circular) heat insulating members P coupled to each other via the connecting members 7.

[0085]

Incidentally, though not shown, a sheet is attached to cover the outer circumferences of the stacked heat insulating members P, thus providing reinforcement and heat insulation performance improvement of the stacked heat insulating members P.

[0086]

(Shaping Tool)

As shown in Fig. 11, there is provided a shaping tool R which has a same cross-sectional shape as the connecting member 7 and has a longer

length than the connecting member 7 and which is harder than the surface of the connecting member 7.

In the instant embodiment, the shaping tool R is formed by using a hard urethane resin having greater hardness than the urethane resin used for producing the connecting member 7 and the heat insulating member P, so that the shaping tool R as a whole is formed harder than the connecting member 7.

[0087]

And, prior to execution of the inserting step of inserting the connecting member 7 into the respective receded groove portions 8 of the adjacent heat insulating members P, as shown in Fig. 11, a shaping step is carried out in which the connecting member 7 or the shaping tool R is inserted to the respective receded groove portions 8 of the adjacent heat insulating member P.

[0088]

Incidentally, this shaping step may be always carried out prior to the execution of the inserting step. Alternatively, the shaping step may be carried out when the insertion of the connecting member 7 has proven difficult after the execution of the inserting step.

[0089]

(Detaching of Heat Insulating Members)

Under the condition that the heat insulating members P adjacent in the circumferential direction are disposed on the outer circumferential portion of the cylindrical tube 1 with the opposed end faces thereof being placed in abutment against each other and the connecting members 7 are inserted into the respective receded groove portions 8 of the adjacent heat insulating members P, when the heat insulating members P are to be detached from the cylindrical tube 1, this operation is carried out by the following procedure.

[0090]

Namely, as shown in Fig. 12, there are carried out one after another a cutting step of cutting the portion of the connecting member 7 which connects the pair of engagement portions 7a along the opposed end faces (shown by the solid line in the illustration) and a detaching step of detaching the heat insulating members P from the cylindrical tube 1 (shown by the virtual line in the illustration).

More particularly, a cutter 10 is inserted to between the opposed end faces 5 of the adjacent heat insulating members P and as this cutter 10 is moved through between the opposed end faces 5 of the adjacent heat insulating members P along the axial direction of the cylindrical tube 1, the cutting step is carried out. Then, the detaching step is carried out for detaching the heat insulating members P whose connection by the connecting member 7 has been released from the cylindrical tube 1.

[0091]

In the instant embodiment, since the small-diameter heat insulating member PS, the intermediate-diameter heat insulating member PM and the large-diameter heat insulating member PL are attached, firstly, as shown in Fig. 12, for the large-diameter heat insulating member PL, the two connecting members 7 are cut along the opposed end faces 5 to detach the large-diameter heat insulating member PL. Next, though not shown, for the intermediate-diameter heat insulating member PM, the two connecting members 7 are cut along the opposed end faces 5 to detach the intermediate-diameter heat insulating member PM. Lastly, for the small-diameter heat insulating member PS, the two connecting members 7 are cut along the opposed end faces 5 to detach the small-diameter heat insulating member PS.

[0092]

Incidentally, in the respective heat insulating member P detached, a remaining portion Z corresponding to a half of the connecting member 7 which was cut will remain. Then, this remaining portion Z will be removed through the entrance portion 8n of the receded groove portion 8 by e.g. moving a pressing tool for pressing out the remaining portion Z through the entrance portion 8n of the receded groove portion 8.

[0093]

Alternatively, for the detachment of the remaining portion, a portion of the end face of the heat insulating member P located on the radially inner side of the receded groove portion 8 may be cut away. In this case, as described above, the retaining receded portion V receded in the radially outer side will be formed at the radially outer portion of the cutaway portion J, so the heat insulating member P will be employed as the end portion heat insulating member PA.

[0094]

(Further Embodiment)

5 In the foregoing embodiment, for forming the three heat insulation layers, the connecting member 7 is inserted to the adjacent heat insulating members P constituting each layer for coupling the adjacent heat insulating members P with each other.

10 In place of the above, as shown in Fig. 13, for forming three heat insulation layers, with respect to the heat insulation layer located on the innermost side, for the adjacent small-diameter heat insulating members PS, the connecting member 7 is not inserted for connecting these adjacent small-diameter heat insulating members PS.

[0095]

15 That is, for at least one or more of the inner side heat insulating layers of the plurality of heat insulating layers, the receded groove portion 8 will not be formed therein and these heat insulating members P will be disposed without insertion of the connecting member 7 to the receded groove portions 8.

[0096]

(Still Further Embodiment)

20 In the foregoing embodiment, in forming three layers of heat insulating layers, there was disclosed a case in which the heat insulating members P constituting each heat insulation layer have a semi-circular shape in the circumferential direction.

25 In place of the above, in case e.g. the cylindrical tube 1 has a large diameter, as shown in Fig. 14, three or more heat insulating members P may be juxtaposed along the circumferential direction by configuring the heat insulating members P constituting each heat insulation layer with a 90-degree arc-shape in the circumferential direction and inserting the connecting member 7 to the circumferentially adjacent heat insulating members P for coupling these heat insulating members P to each other.

[0097]

35 Namely, in the foregoing embodiment, the cylindrical tube 1 has an outside diameter of about 30 mm. In this still further embodiment, the cylindrical tube 1 has a large outside diameter of about 300 mm. For this reason, the heat insulating members P are provided in the form of 90-degrees arc-shape.

[0098]

In this way, in case three or more heat insulating members P are to be juxtaposed along the circumferential direction, advantageously, prior to attachment of the heat insulating members P to the cylindrical tube 1, for some heat insulating members P of the plurality of heat insulating layers P, there may be carried out a "pre-assembling step" in which the connecting member 7 is inserted to the receded groove portions 8 of the respective heat insulating members P adjacent in the circumferential direction, with the opposed end faces thereof being placed in abutment against each other.

[0099]

Namely, for instance, as shown in Fig. 14, in case four heat insulating members P are to be juxtaposed in the circumferential direction, by the pre-assembling step, respective two of the four heat insulating members P will be pre-assembled and thereafter, there may be carried out a disposing step of disposing the pre-assembled two sets of heat insulating members P on the outer circumferential portion of the cylindrical tube 1 and the inserting step of inserting the connecting members 7 one after another.

[0100]

In case such pre-assembling step is to be carried out, as shown in Fig. 15, in the case of implementing the end portion attachment arrangement with juxtaposing four end portion heat insulating members PA in the circumferential direction, two each of the four end portion heat insulating members PA may be pre-assembled and thereafter, these two sets of pre-assembled end portion heat insulating members PA may be assembled to the coupling members B.

[0101]

(Further Arrangements of Receded Groove Portion)

When the receded groove portion 8 is provided in the shape of a groove along the longitudinal direction of the heat insulating member P and the wide portion 8w is formed along the circumferential direction with a greater width in the thickness direction than the opening width Hn of the entrance portion 8n along the thickness direction of the heat insulating member P, this may be done alternatively as shown in Fig. 16 or still alternatively as shown in Fig. 17.

[0102]

In the modified form shown in Fig. 16 and the further modified mode shown in Fig. 17, the receded groove portion 8 is configured to include a circumferentially receded portion 8u receded from the entrance portion 8n along the circumferential direction and two radially receded portions 8a receded toward the radially outer side and the radially inner side from the end portion of the circumferentially receded portion 8u to form the wide portion 8w.

[0103]

However, in the modified mode shown in Fig. 16, the two radially receded portions 8a have a triangular shape whereas in the further modified mode shown in Fig. 17, the two radially receded portions 8a have a circular shape, respectively.

Incidentally, in the case of the modified mode shown in Fig. 16 and the further modified mode shown in Fig. 17, in order to form the wide portion 8w, the receded groove portion 8 is provided with the radially receded portions 8a receded to the radially outer side. Therefore, when the connecting member 7 is not inserted, by cutting away the portion in the end face of the heat insulating member P located on the radially inner side of the receded groove portion 8, at the radially outer portion of this cutaway portion J, the retaining receded portion V receded to the radially outer side can be formed.

[0104]

(Further Modes of Connecting Member)

When the connecting member 7 is to be configured to include the main body portion 7A extending in the circumferential direction and the pair of engagement portions 7a engageable with the radially receded portion 8a, as shown in Fig. 18, in the further mode of forming the receded groove portion 8, the radially receded portion 8a will have a triangular shape, whereas in the still further mode, the radially receded portion 8a will have a circular shape.

[0105]

Incidentally, Fig. 18 illustrates that for the formation and provision of the two heat insulation layers using the semi-circular heat insulating members P, the still further mode is employed for the inner side layer and the further mode is employed for the outer side layer.

[0106]

[Other Embodiments]

Next, other embodiments will be explained one by one.

5 (1) In the foregoing embodiment, there was disclosed a case in which the heat insulating member P has a semi-circular shape halved or divided into four parts along the circumferential direction of the cylindrical tube 1. However, the invention is not limited thereto. The heat insulating member P may be divided into three parts or five or more parts along the circumferential direction of the cylindrical tube 1.

10 [0107]

(2) In the foregoing embodiment, the heat insulating member P, the connecting member 7 and the coupling member B were formed of a same material. However, the invention is not limited thereto. The coupling member B and the connecting member 7 may be formed of a material different from material forming the heat insulating member P.

[0108]

20 (3) In the foregoing embodiment, the material of the heat insulating member P was urethane resin. However, the material of the heat insulating member P is not limited thereto. For instance, the material of the heat insulating member P may be polyethylene resin, poly isocyanate (PIR), etc..

[0109]

25 (4) In the foregoing embodiment, there was disclosed a case in which on the outer circumferential portion of the cylindrical tube 1, three heat insulation layers are formed as a plurality of heat insulation layers. However, it is also possible to embody with forming two heat insulation layers or four or more heat insulation layers.

[0110]

30 (5) In the foregoing embodiment, the cylindrical tube 1 was employed as the "heat insulation object". However, the heat insulation object is not limited thereto. For instance, the heat insulation object may be a hollow spherical reservoir tank for reserving an amount of cold fluid W such as LNG, etc.

[0111]

35 Incidentally, the arrangements disclosed in the foregoing embodiments (including the further embodiments) may be used in any

combinations with the arrangements disclosed in any other embodiment unless contradiction results from such combinations. Further, it is noted that the embodiments disclosed in this detailed disclosure are only exemplary and embodiments of the present invention are not limited thereto, but may be modified in any appropriate matter within a range not deviating from the object of the present invention.

DESCRIPTION OF REFERENCE SIGNS

[0112]

10	1:	cylindrical tube (heat insulation object)
	5:	opposed end face
	7:	connecting member
	7a:	engagement portion
	8:	receded groove portion
15	8a:	radially receded portion
	8n:	entrance portion
	8u:	circumferentially receded portion
	B:	coupling member
	Hn:	opening width
20	Hw:	wide portion
	J:	cutaway portion
	P:	heat insulating member
	V:	retaining receded portion

CLAIMS

1. A method of attaching a heat insulation structure comprising a plurality of heat insulating members juxtaposed along a circumferential direction of a cylindrical or hollow spherical heat insulation object to be cooled by a cold fluid for covering an outer circumference of the heat insulation object for its heat insulation, wherein:

at an end face of a heat insulating member opposed to a further heat insulating member adjacent thereto in the circumferential direction, a receded groove portion receded in the circumferential direction from the opposed end face is preformed in a form of a groove along a longitudinal direction of the heat insulating member and including, on the back side thereof along the circumferential direction, a wide portion which has a greater width than an opening width of an entrance portion along a thickness direction of the heat insulating member;

a connecting member elongate along the longitudinal direction of the heat insulating member is preformed to include, along the circumferential direction, a pair of engagement portions engageable with the receded groove portions of the respective heat insulating members adjacent in the circumferential direction; and

when the heat insulating members are to be attached to the heat insulation object, the method carries out one after another a disposing step of disposing the heat insulating members adjacent in the circumferential direction on an outer circumferential portion of the heat insulation object with the opposed end faces thereof being placed in abutment against each other, and an inserting step of inserting the connecting member to the receded groove portions of the respective heat insulating members adjacent to each other.

2. The method of attaching heat insulation structure of claim 1, wherein:

the heat insulation object comprises a cylindrical tube in which the cold fluid flows; and

the heat insulating member is in the form of a plate extending along an axial direction of the cylindrical tube and also in the form of an

arc-shaped curved plate as seen in the axial direction.

3. The method of attaching a heat insulation structure of claim 2, wherein:

5 three or more said heat insulating members are juxtaposed along the circumferential direction; and

when the heat insulating members are to be attached to the cylindrical tube, for one or some of the plurality of heat insulating members, the method carries out a pre-assembling step in which the
10 connecting member is inserted to the receded groove portions of the respective heat insulating members adjacent in the circumferential direction, with the opposed end faces thereof being placed in abutment against each other, and the group of the heat insulating members assembled at the pre-assembling step is disposed at the disposing step.

15 4. The method of attaching a heat insulation structure of claim 2 or 3, wherein:

as the heat insulating members, there are provided a plurality of kinds of heat insulating members having curvature radii different from
20 each other in order to form a plurality of heat insulation layers in a radial direction of the cylindrical tube, with a further heat insulating member being attached to an outer circumferential portion of the heat insulating member attached in advance; and

when the heat insulating members are to be attached to the heat
25 insulation object, the plurality of kinds of heat insulating members are attached in such a manner that the smaller the curvature radii of the heat insulating members, the earlier the heat insulating members are attached.

30 5. The method of attaching a heat insulation structure of claim 4, wherein in at least one or some of the inner side heat insulation layers included in the plurality of heat insulation layers, the receded groove portion is not formed and the heat insulating member is disposed without insertion of the connecting member to the receded groove portion.

35 6. The method of attaching a heat insulation structure of

claim 4 or 5, wherein the heat insulating members are disposed in such a manner that opposing portions at which the opposed end faces of the heat insulating members adjacent in the circumferential direction are placed in abutment against each other are made different in phase in the circumferential direction in the heat insulation layers adjacent in the radial direction of the plurality of heat insulation layers.

7. The method of attaching a heat insulation structure of any one of claims 2-6, wherein:

the receded groove portion includes a circumferentially receded portion which is receded from the entrance portion along the circumferential direction and a radially receded portion which is receded from an end portion of the circumferentially receded portion as the wide portion toward the radially outer side;

when the connecting member is not inserted, a portion in the end face located on the radially inner side of the receded groove portion is cut away to form a cutaway portion, and at a radially outer portion of the cutaway portion, there is formed a retaining receded portion which is receded radially outwards;

a coupling member elongate along a longitudinal direction of the heat insulating member is preformed to include, along the circumferential direction, a pair of retaining protruding portions engageable with the retaining receded portion of the respective heat insulating member adjacent in the circumferential direction; and

when the heat insulating members adjacent in the circumferential direction are to be disposed with the opposed end faces thereof being placed in abutment against each other, the retaining receded portion is engaged with the coupling member disposed in advance.

8. The method of attaching a heat insulation structure of any one of claims 1-7, wherein:

prior to the inserting step, the method carries out a shaping step in which the connecting member or a shaping tool is inserted to the respective receded groove portions of the adjacent heat insulating members; and

the shaping tool has a cross sectional shape which is same as that

of the connecting member and a longer length than the connecting member and at least surface of the shaping tool is formed harder than the surface of the connecting member.

5 9. A method of detaching a heat insulation structure comprising a plurality of heat insulating members juxtaposed along a circumferential direction of a cylindrical or hollow spherical heat insulation object to be cooled by a cold fluid for covering an outer circumference of the heat insulation object for its heat insulation, 10 wherein:

 at an end face of a heat insulating member opposed to a further heat insulating member adjacent thereto in the circumferential direction, a receded groove portion receded in the circumferential direction from the opposed end face is preformed in a form of a groove along a longitudinal 15 direction of the heat insulating member and including, on the back side thereof along the circumferential direction, a wide portion which has a greater width than an opening width of an entrance portion along a thickness direction of the heat insulating member;

 a connecting member elongate along the longitudinal direction of 20 the heat insulating member is preformed to include, along the circumferential direction, a pair of engagement portions engageable with the receded groove portions of the respective heat insulating members adjacent in the circumferential direction;

 the heat insulating members adjacent in the circumferential 25 direction are disposed on an outer circumferential portion of the heat insulation object with the opposed end faces thereof being placed in abutment against each other and with the connecting member being inserted to the respective receded groove portions of the heat insulating members adjacent thereto; and

30 when the heat insulating members are to be detached from the heat insulation object, the method carries out one after another a cutting step of cutting a portion of the connecting member used for connecting the pair of engagement portions along the opposed end faces and a detaching step of detaching the heat insulating members from the heat 35 insulation object.